Sterilization of Dominant Males Will Not Limit Feral Horse Populations

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Research Paper RM-226
Rocky Mountain Forest and
Range Experiment Station
Forest Service
U.S. Department of Agriculture

USDA Forest Service
Research Paper RM-226

December 1980

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Abstract

Sterilization of dominant stallions is impractical for controlling feral horse populations. Evidence does not support the premise that reproductive units are stable, with one male and many females. Individual horses, including reproductively active females, move between bands during the breeding season.

[1]The author was a graduate student, New Mexico State University, Las Cruces. This research was supported by the Rocky Mountain Forest and Range Experiment Station with headquarters at Fort Collins in cooperation with Colorado State University and by the New Mexico State University Agricultural Experiment Station in Las Cruces. The manuscript was submitted as New Mexico State University Agricultural Experiment Station Journal Article 774. Supervision was provided by David R. Patton, project leader at the Station's research work unit at Tempe in cooperation with Arizona State University.

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Management Implications

Permanent or temporary sterilization of the dominant stallion in a feral horse herd has been suggested to control horse populations. This control method would work only if bands of horses were stable, if reproductive units consisted of one male and many females, and if females did not move between bands. A study of the behavior of bands of horses from the Jicarilla herd shows that female fidelity is weak or nonexistent and that some breeding in the bands is by subdominant males. The amount of sterilization that would have to be done to control horse numbers indicates that the technique is not practical. Another reason to avoid selective sterilization of dominant males is that these animals represent the best genetic material for the population.

Introduction

The Wild Free-Roaming Horses and Burros Act (PL 92-195) of 1971 provides federal protection and custody for feral equids, including feral horses (*Equus caballus*), on specified public lands. Prior to 1971, feral horse populations were limited through relatively unrestricted removal of animals. Since protection began in 1971, some of these populations may have increased at rates approaching 20-25% per year (Blaisdell 1977), resulting in overuse of available resources (Hall 1972). An acceptable method is needed to regulate feral horse numbers at levels compatible with environmental constraints while maintaining the populations at viable levels.

Population management has three distinct goals: (1) to keep a species on a "sustained yield basis" (harvest game management); (2) to increase the density of a species that is dangerously low (endangered species management); or (3) to decrease the density of a species (pest management) (Caughley 1976). With respect to feral horse populations on western rangelands, population management might be viewed as an amalgamation of goal 2, maintaining viable populations of feral horses, and goal 3, limiting growth of local populations that reach pest proportions.

One suggested technique for imposing population control artificially is temporary or permanent sterilization of the dominant stallions in a feral horse population to reduce the rate of reproduction (Baxter 1977, Frei 1977). The technique is appealing because it requires manipulation of only a few animals, and it is acceptable to various agencies and preservation groups (National Wild Horse Forum 1977).

The hypothesis that sterilization of dominant stallions would control population is based on the following assumptions:

1. Only certain males (harem stallions) participate in the breeding.
2. The number of breeding males is small relative to the number of reproductively active females, so that one male breeds many females.
3. A feral horse society is composed of groups that are stable over time.
4. Any changes in band affiliations are primarily among the immature, prereproductive individuals in the population.

If any of these seemingly plausible assumptions is untrue, sterilization is not practical as an artificial means of imposing density limitations.

This hypothesis thus raises questions on feral horse biology: What is the sex and age composition of the population? When do mating and parturition occur? At what age do both males and females reach sexual maturity? What type of social organization is expressed? Are the dominant stallions of feral horse bands doing all of the breeding within their bands? Do peripheral males participate in breeding receptive females? How stable are feral horse bands, and how much exchanging of members between bands occurs? How are bands formed and who forms them?

Only recently have there been attempts to obtain information on the population biology of feral horses (Feist 1971, Feist and McCullough 1976, Green and Green 1977, Hall 1972, Hall and Kirkpatrick[2]).

Various authors have described the social organization of both wild and feral equids. Generally, they have noted two distinct types: those equids in which the males are strictly territorial, such as in Grevys zebra (*Equus grevyii*) (Klingel 1969a, 1975a, 1975b), in some

[2]*Hall, R., and J. F. Kirkpatrick. 1975. Biology of the Pryor Mountain Wild Horse. Unpublished report, 21 p. Bureau of Land Management, Salt Lake City, Utah.*

feral ass (*E. asinus*) populations in Death Valley (Moehlman 1974), and those equids in which the males are nonterritorial and form harem units, such as in plains zebra (*E. quagga*), mountain zebra (*E. zebra*) (Klingel 1966, 1967, 1968, 1969b, 1975b), and feral horse (*E. caballus*) (Fiest 1971, Feist and McCullough 1976, Green and Green 1977).

Feist (1971), Feist and McCullough (1976), and Green and Green (1977) stressed the highly stable nature of the harem social unit in their studies of feral horse populations. Band stability, it is hypothesized, is determined by the stallion's dominance over the other individuals of his band. Interchanges that did occur were primarily in the prereproductive segment of the population. Thus, a feral horse society is thought to be one of female fidelity to a particular band and not one of sporadic association with many different bands.

It can be concluded from computer simulations of population responses to changes in demographic parameters that sterilization of the dominant stallions is an impractical method of population control (Nelson 1978). It was shown that to initiate a population decline, the percent of successful breeding of females must be reduced to less than 10% (fig. 1).

Another method of control of these populations appears to be continuous cropping of 15% of the population per year. Cropping of entire band units would cause the least disruption to the social structure of the entire population. For a discussion of such a cropping procedure, see Fowler and Smith (1973). For a more thorough discussion of the computer simulations see Nelson (1978).

The research presented here is an evaluation of male sterilization techniques based on observations of population biology.

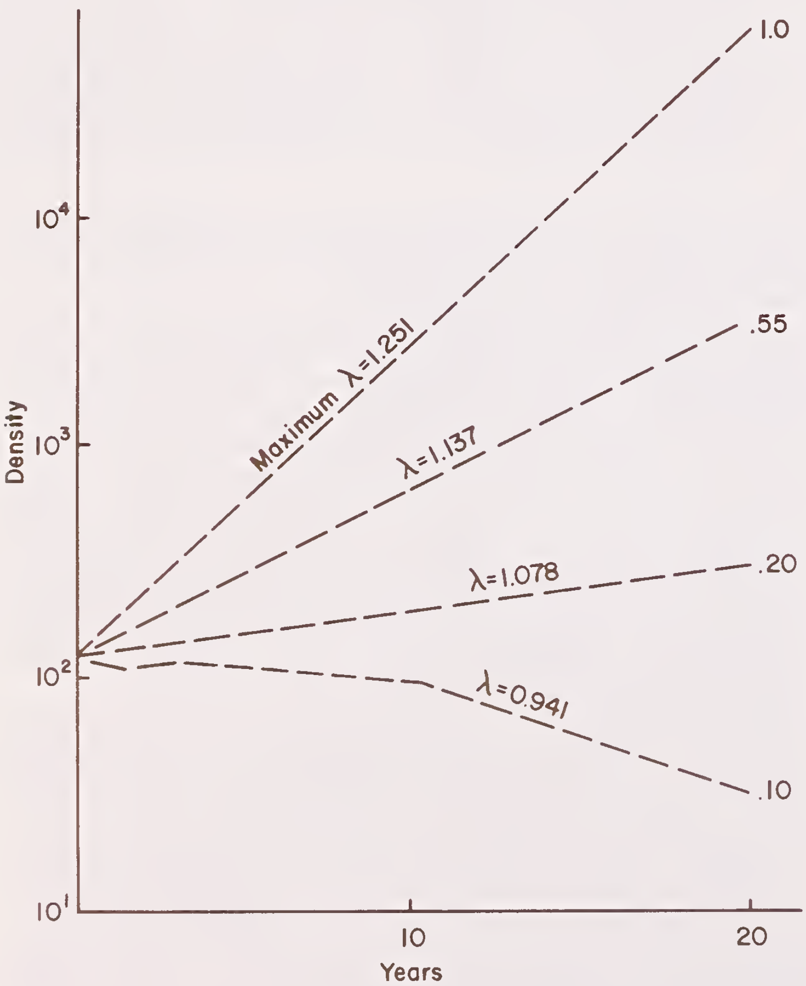

Figure 1.—Changes in the finite rate of increase in a feral horse population as a result of varying percent breeding. Proportion breeding shown at end of each line.

Study Area

The study area was on the Jicarilla District of the Carson National Forest, 90 km northeast of Farmington, N. Mex. The northern portion of this public land has been designated as the Jircarilla Wild Horse Territory and is approximately 29,000 ha. This study was restricted to 14,200 ha. The study area is heterogeneous, including four major canyons (10,000 ha) administered by the USDA Forest Service (FS) and 4,200 ha of land administered by the Bureau of Land Management (BLM). There is movement of feral horses across the FS-BLM boundary line.

Topographic features include wide canyon bottoms, steep-sided rocky slopes, and broad mesas. Elevations range from 1,800 to 2,275 m. The area lies within the San Juan Basin, with underlying rock of the Wasatch and Naciminento formations. The mesa soils are of sandstone origin and quite variable. The slopes and bottomlands are a mixture of soils derived from shale and sandstone and are easily eroded (Dane 1948, Simpson 1950). There are alluvial deposits 6 m or more in depth in the main canyons; canyon bottoms vary in width from a few hundred meters to 1.5 km or more. Deep gullies have been cut through the alluvia, and sheet erosion is common.

Precipitation occurs in the form of winter snow and summer rains. Water availability is limited during the dry months prior to the onset of summer rains. The development of stock tanks to hold runoff and the presence of intermittent springs along the main canyons provide water sources during the drier months. With the onset of the summer rainy season, water is readily available throughout the area.

Vegetative types include sagebrush-grass association, pinyon-juniper woodland association, pinyon-juniper/sagebrush-grass ecotone association, pine/Douglas-fir association, and revegetation association.

Approximately 800 ha of range revegetation has been done in the study area over the past 10 years. These areas begin vegetative growth 3 to 5 weeks earlier than the surrounding nonmanipulated land. A corresponding increase in use of these areas by feral horses, mule deer (*Odocoileus hemionus*), and elk (*Cervus elaphus*) was noted in response to early spring growth. Revegetation areas provide an important food source before spring growth begins on other parts of the range. A substantial road network exists on the study area enabling fairly complete coverage from a vehicle.

Methods

This study involved intensive observation of daily and seasonal activity of selected feral horse bands. The usual procedure was to observe a band for 4 to 12 hours. Most of the study area was visited at least every 2 or 3 days.

A 20X spotting scope, 8X binoculars, and a tape recorder were used. Observations were recorded in three formats, adapted from procedures outlined by Altmann (1974). Behavior-time matrices, including both social and nonsocial behaviors, were constructed for observations of bands and individuals within bands. The number of horses engaged in different activities was recorded at 5-minute intervals, and the relative position of the horses plotted. During each hour that a band was observed, activities of a randomly chosen individual were observed for 30 minutes and recorded separately. For individuals, observed activities were noted as occurring within any given minute during the 30-minute observation period (Lagerspetz 1964, Conley 1976). Band identification, date, time, weather conditions, vegetative association, and location were recorded for all observations. In addition, sex, age, identifying color and marks, and familial relationships (as discernible) were recorded on the individual's data sheets. A continuous account of all other behavior was recorded throughout an observation period in conjunction with the other two formats. From these three methods of recording information, construction of a complete behavior profile is possible for both individual and group activity patterns over the course of a year.

An aerial count of the feral horse population was conducted January 18-20, 1977, after sufficient snowfall to facilitate observation. This aerial survey and knowledge of the number of horses in the study area were used to estimate total population size.

Fieldwork began on September 13, 1976, and terminated August 17, 1977. Approximately 1,100 hours of behavior observations on individual horse bands and 400 hours of behavior observations on individuals within bands were recorded during the field study.

Results

The aerial census revealed 226 individuals in this population. The population segment that received intense study consisted of 116 individuals in 17 different bands. Each band included a mature stallion, one to six mature females and their offspring, and an assortment of immature females not necessarily of familial relation. Two bands contained more than one stallion.

Table 1 shows the age structure and composition of this population segment. Four age classes could be recognized: (1) foal, individuals up to 1 year of age; (2) yearling, individuals from 1 to 2 years of age; (3) immature, individuals from 2 to 3 years of age, and (4) mature, individuals 3-1/2 years and older. Some overlap exists in the immature and mature age classes

Table 1.—Sex and age composition of the population segment that received intense study in summer 1977

	Foal	Yearling	Immature	Mature	Total	Percent
Male	12	7	10	17	46	39.7
Female	9	9	14	38	70	60.3
Total	21	16	24	55	116	100.0
Percent of total population	18.1	13.8	20.7	47.4	100.0	
Ratio of males to females	1.33	0.77	0.71	0.44	0.66	

because of difficulty in determining the age of certain females. If the three youngest age classes are grouped together, 52.6% of the population was born between 1975 and 1977.

Very little is known of reproduction in feral horses. Nishikawa et al. (1952), Hafez and Jainudeen (1974), and Nishikawa and Hafez (1974) gave a thorough summary of reproduction in domestic horses. A brief description of reproduction in domestic horses provides a reference to evaluate feral horse reproduction. In domestic stallions, sexual maturity may be attained before the age of 2 years. Testicular growth begins at 11 months with spermatogenesis occurring by 12 months. Males possess viable sperm year-round, although photoperiod appears to affect both the quantity and quality of semen. A domestic stallion can normally service 60 to 80 females during the breeding season. In female domestic horses, sexual maturity may be attained as early as 12 to 18 months. Estrous may be acyclic at first, then becomes cyclic. The length of the estrous cycle varies from 16 to 24 days, and duration of estrus itself is 3 to 11 days. Ovulation occurs 24 to 48 hours prior to the end of estrus. Diestrus lasts 14 to 19 days when ovulation occurs and 7 to 10 days when ovulation does not occur. The duration of gestation is 340 ± 30 days. A post-partum estrus may occur 5 to 15 days following birth. In domestic horses, reproductive efficiency is low, with a 60-65% conception rate and 50% foaling rate. Abortion frequency is 10% with mares 3 to 6 years old having the lowest abortion frequency. Prenatal mortality is common to lactating mares mated early in the season and to those which conceive during post-partum estrus.

Based on recent field observations of feral horse populations, it appears that reproduction in feral horses is similar to that in domestic horses. Feist (1971) and Feist and McCullough (1975) observed that 43.2% of mature females foaled in 1970. Two mares in the immature age class foaled, and two sets of twins also were noted. The breeding season of this population of feral horses was restricted to the spring and summer, with all foals born between April and June, and a peak in foaling in May. All mating occurred within the

harem unit with all copulations by the dominant male stallion. The behavioral sequences of mating have been described by Feist and McCullough (1976).

In the Jicarilla feral horse population, mating was observed throughout the year. Most observed copulations coincided with the spring and summer foaling season. Of 19 observed copulations, 17 were by dominant harem stallions. These stallions copulated with female members of their own bands and other receptive females. Nine of the observed copulations were with females from another band.

Evidence does not support the premise of stable reproductive units. Fidelity to a particular band is weak or nonexistent in many females of this population.

Twenty-one foals were born to the 38 mares in the mature class giving a 0.55:1 ratio. There were no twins. This rate of recruitment indicates most females do not foal in successive years, a finding that is further supported by field observations that 29% of the mares had foals in each of the past 2 years. The peak foaling period in this population occurred from April through May. By the end of May, 66% of all foals had been born, although foaling continued through the end of August.

There were differences in reproductive effort between females with access to revegetation areas and females without such access. Females with access to these areas began foaling on April 6 and completed foaling in May. Other females began foaling on May 3 and continued through August. Of the mature females, 64% had access to revegetation areas. These females contributed 73% of the foals (table 2).

Mortality was low in this feral horse population. During the study, 25 skulls were collected and age-at-death estimates were derived using tooth-eruption and tooth-wear criteria following procedures used by Ensminger (1969). Twenty-two of these horses were less than 12 years of age at the time of death. The presence of canine teeth indicated 15 of the skulls were from male horses (Ensminger 1969). There was no mortality in the foal class. Of 21 foals born in the spring and summer of 1977, all survived through August 1977 when this study ended. It is possible some mares gave birth to foals that died prior to being observed.

Table 2.—Differences in reproductive effort of females with access to revegetated areas and females without access

Activity area	Females	Foals	Foal to mare ratio	Standard error
	percent			
Revegetated areas	64	72	0.62	± 0.08
Nonrevegetated areas	36	28	.43	± .10
Total	100	100	.55	± .06

Different mortality rates between sexes are evident in this population. The male to female ratio at birth approaches 1.0; however, the sex ratio approaches 0.4 in the mature age classes. This suggests that males are incurring higher mortality or that a disproportionate number of males left the study area. Of 10 males in the immature age class, only 4 were in harem units, while all 14 females in this immature class associated with one or more harem bands.

Mountain lion (*Felis concolor*) and coyote (*Canis latrans*), both present in the study area, are potential predators on feral horse populations (Dobie 1952, Young and Goldman 1946). However, no deaths within this population could be attributed to predation during the study.

Observations suggest that survival patterns are characterized by low mortality in the foal and yearling classes, and higher male mortality in the immature and mature age classes. Dispersal movements are included as a component of mortality estimates, thus making estimates conservative.

Social Structure

A band is a recognizable aggregate of individuals in a somewhat stable association. A band may be a harem group or it may be an all-male aggregation of immature, subdominant members of the population. Female aggregations were not classified as bands because they were in frequent association with one or more harem groups over the course of the year. An assumption in this study was that the stallion is the alpha individual, thus band identity was determined by his presence or absence. Most bands contain a core of individuals which usually remain together with the stallion. I have called such a group the primary band. If a female was recognized as a member of a particular band but was not with the stallion, she was classified as out of the band.

The dynamics of group formation and group structure are of particular importance in a social system. Feral horse bands were formed in four ways: (1) peripheral males acquiring females from existing bands (observed three times); (2) peripheral males forming a band with females which had previously been moving between bands (observed twice, although neither was permanent); (3) a peripheral stallion assuming control over a harem band following disappearance of the dominant stallion (observed once); and (4) bands splitting into two new bands as a result of competition between two mature males (observed once and appeared to be happening in another band at the close of field observations).

Size and composition of some bands were fairly stable while others were unstable. Changes in band size and composition occurred throughout the year, but there was a strong seasonal pattern in some bands. The monthly mean size of each band indicated an increase in general movements of individuals between bands and out of bands during the spring and summer months. Certain bands having access to revegetation areas exhibited greater interchange of members be-

tween bands (fig. 2). Prior to the onset of breeding and parturition in late March, these bands begin to break up, with females and their offspring moving between adjacent bands. By May, very few females were with their primary band, and were either with another band, by themselves, or with all-female factions of a previous band. Bands not having access to revegetation areas appeared to be relatively stable (fig. 3). Considerable movement occurred even among the more stable bands but was usually short-term, with individuals returning to their primary band (fig. 4).

Sixty-one percent of the females in the study area were either alone, or with other females and no stallion, or in association with another band at some time during the year. Females moved more during the time of breeding and parturition. This amount of movement would not necessarily negate the hypothesis that the population could be controlled by sterilizing dominant males, provided the animals involved in the movement were the nonreproductive and/or immature segments of the population. However, the most active segment of females were mature (78% of the observed movements). Immature females had a higher movement activity in the fall and winter periods. Yearling females generally stayed with their primary band, moving only with other females.

Discussion

These findings suggest that dominant males do most of the breeding and that there are few such males relative to the number of sexually active females. However, the majority of the observations were of bands which included a dominant stallion, resulting in a bias in favor of such observations. While copulations involving peripheral stallions were not observed, the fact that females associate with these males at various times, and spend long periods of time outside any harem band, suggests that some reproduction may be attributable to these males.

An explanation for the disproportionate sex ratio in the mature age class is not readily available. Two solitary stallions and one group of five immature and subdominant stallions were observed during the study. Dispersal of males to areas outside the study area or differential mortality directed toward the male segment of the population are two possible reasons for the observed imbalance; however, it seems possible that males from other areas would immigrate into this population segment, resulting in no net changes.

Most movements of individuals between bands or out of bands coincided with the breeding season. Not only was there movement between groups, but this movement included the reproductively active females. The high percentage of the female population involved in either long- or short-term movements outside the primary band negates the effectiveness of male-limited population control. Evidence that over 50% of the observed copulations were with females from other bands further indicates the ineffectiveness of sterilizing only certain harem stallions.

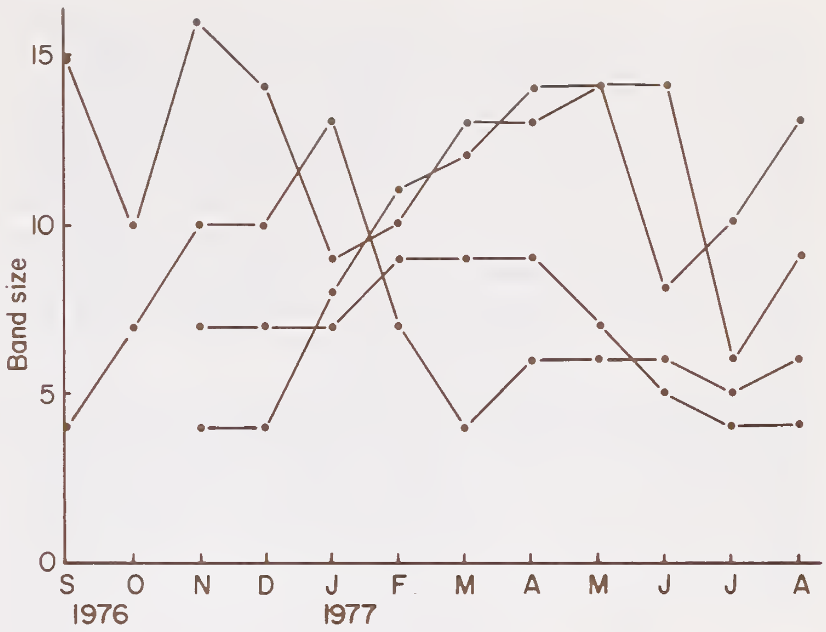

Figure 2.—Maximum monthly band size of four bands with access to revegetated areas.

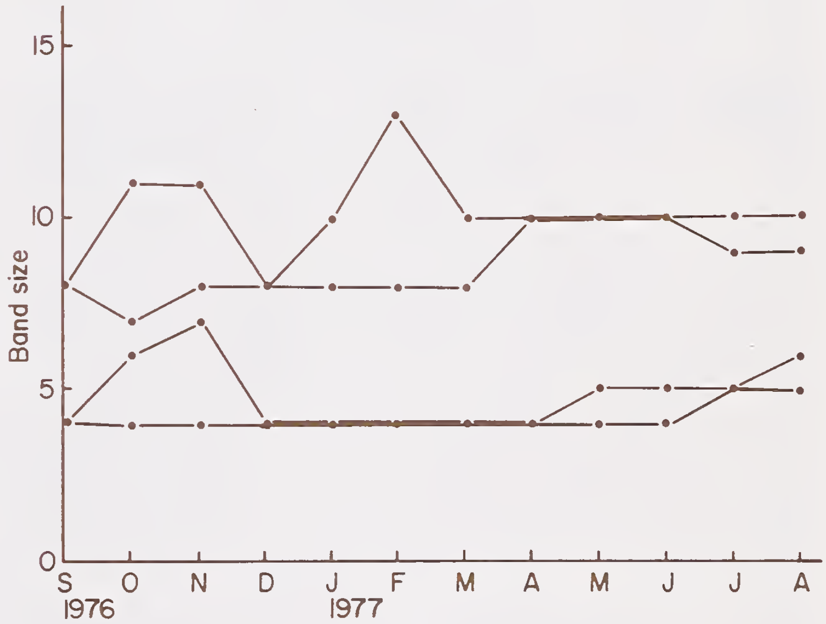

Figure 3.—Maximum monthly band size of four bands without access to revegetated areas.

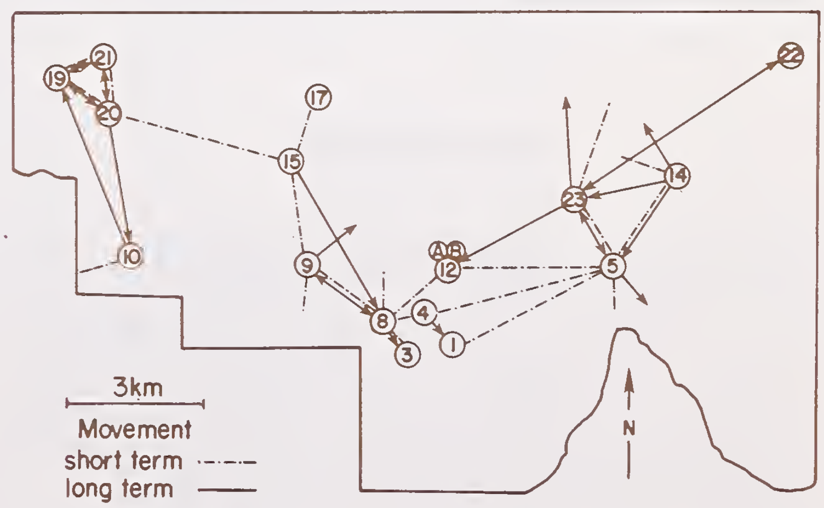

Figure 4.—Movement of individuals between bands and out of bands within the study area in the Jicarilla feral horse population.

Given the potential of feral horse populations to increase as evidenced in the past few years, it seems unlikely that sterilizing dominant males would reduce reproduction enough over the time necessary to cause a decline in numbers. Approximately 25% of the harem stallions were replaced each year. If these observations are representative of feral horse populations in general, male-sterilization techniques would have to be implemented on a yearly or every-other-year basis, an impractical management approach.

In addition to failing to limit the population, selective sterilization of alpha males would eliminate the major contributors of quality genetic material from the gene pool. Breeding by peripheral, subdominant males, might then introduce inferior genotypes, a result which runs counter to the management objective of maintaining viable feral horse populations.

Future Research

The biology of this population has been made more complex by the differential behavior of individuals with access to revegetation areas compared to those without access to such areas. The higher foal:mare ratio of females with access to revegetated areas implies increased reproductive value with increasing nutritional resources. Clegg and Ganong (1969) found that domestic mares would breed at any season if well fed. Hall (1972) relates reproductivity to nutrition in the Pryor Mountain feral horse population, since foaling coincided with the onset of spring growth of vegetation. That these females with access to revegetation areas are foaling earlier in the spring suggests that the timing of reproductive efforts are tied to differences in forage availability and are in this sense vegetation generated. While these differences do not directly relate to the questions of limiting population growth by sterilizing dominant males, a management alternative might be to concentrate on those groups of animals which exhibit higher production, if the goal is to limit growth of the population. Research completed by the University of Arizona will provide new information on the use of revegetated areas by wild horses.[3]

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Forest Service

Rocky Mountain Forest and Range Experiment Station

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

Albuquerque, New Mexico
Bottineau, North Dakota
Flagstaff, Arizona
Fort Collins, Colorado*
Laramie, Wyoming
Lincoln, Nebraska
Lubbock, Texas
Rapid City, South Dakota
Tempe, Arizona

*Station Headquarters: 240 W. Prospect St., Fort Collins, CO 80526